NEOSHO RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: John Redmond Lake
Water Quality Impairment: Eutrophication

Subbasin: Neosho Headwaters

Counties: Butler, Chase, Coffey, Greenwood, Harvey, Lyon, Marion, McPherson, Morris, and Wabaunsee

HUC 11 (HUC 14)**:** **11070201 010** (010, 020, 030, 040, 050, 060)
11070201 020 (010, 020, 030, 040, 050, 060, 070, 080, 090)
11070201 030 (010, 020, 030, 040, 050)
11070201 040 (010, 020, 030, 040, 050, 060, 070)

11070202 010 (010, 020, 030, 040, 050, 060, 070, 080)
11070202 020 (010, 020, 030, 040, 050)
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11070202 040 (010, 020, 030, 040, 050)

11070203 010 (010, 020, 030, 040)
11070203 020 (010, 020, 030, 040, 050)
11070203 030 (010, 020, 030, 040, 050)
11070203 040 (010, 020, 030, 040, 050, 060)

Ecoregion: Flint Hills (28)
Central Irregular Plains/Osage Cuestas (40b)
Central Great Plains/Smoky Hills (27a)

Drainage Area: Approximately 3,000 square miles.

Conservation Pool: Area = 7,643 acres
Watershed Area: Lake Surface Area = 251:1
Maximum Depth = 4.0 meters (13 feet)
Mean Depth = 1.5 meters (4.9 feet)
Retention Time = 0.04 years (0.5 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Industrial Water Supply Use; Food Procurement

Authority: Federal (U.S. Army Corps of Engineers), State (Kansas Water Office)

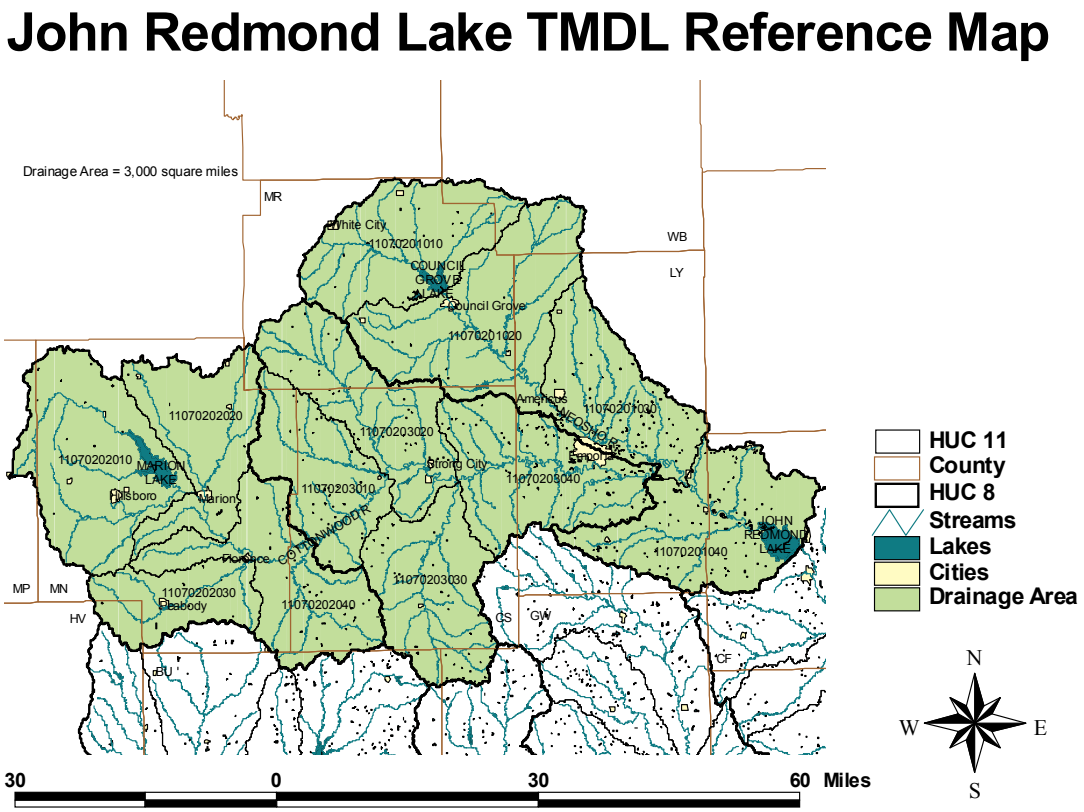
1998 303d Listing: Table 4 - Water Quality Limited Lakes

Impaired Use: All uses are impaired to a degree by eutrophication

Water Quality Standard: Nutrients - Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR 28-16-28e(c)(2)(B)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation. (KAR 28-16-28e(c)(7)(A)).

Figure 1



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Argillotrophic, Trophic State Index = 48.98

Monitoring Sites: Station 026001 in John Redmond Lake (Figure 1).

Period of Record Used: Five surveys during 1987 - 1999.
Kansas Biological Survey (1999 - 2000)

Current Condition: John Redmond Lake has chlorophyll a concentrations averaging 6.53 ppb (Appendix A). This relates to a Trophic State Index of 48.98. Sampling done by KDHE shows elevated total phosphorus concentrations (averaging 175 ppb). One hundred percent of the samples are over 50 ppb. The Total Kjeldahl Nitrogen concentrations average 0.84 mg/L; nitrate concentrations average 0.70 mg/L; and nitrite is often below the detection limit. Light is indicated to be the primary limiting factor (Appendix B). Surface water in John Redmond Lake has high turbidity, dominated by inorganic materials because the lake receives a steady inflow of silt. Bioassays preformed by the Kansas Biological Survey indicate that nitrogen and phosphorus are co-limiting. The chlorophyll a to total phosphorus yield is low; the algal production is reduced because light cannot penetrate through the turbid water.

There is an accompanying TMDL for sediment in John Redmond Lake. Because much of the phosphorus entering the lake is attached to sediment, the reductions in total suspended solids will lead to total phosphorus reductions. The relationship between total suspended solids and total phosphorus concentrations were determined by developing a regression of the data from station 273, located at Neosho River at Neosho Rapids (Appendix D). The current condition and load reductions of total phosphorus were calculated from this regression.

The Trophic State Index is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentrations over 7 μg/l and hypereutrophy occurs at levels over 30 μg/l. The Carlson TSI, derives from the chlorophyll concentrations and scales the trophic state as follows:

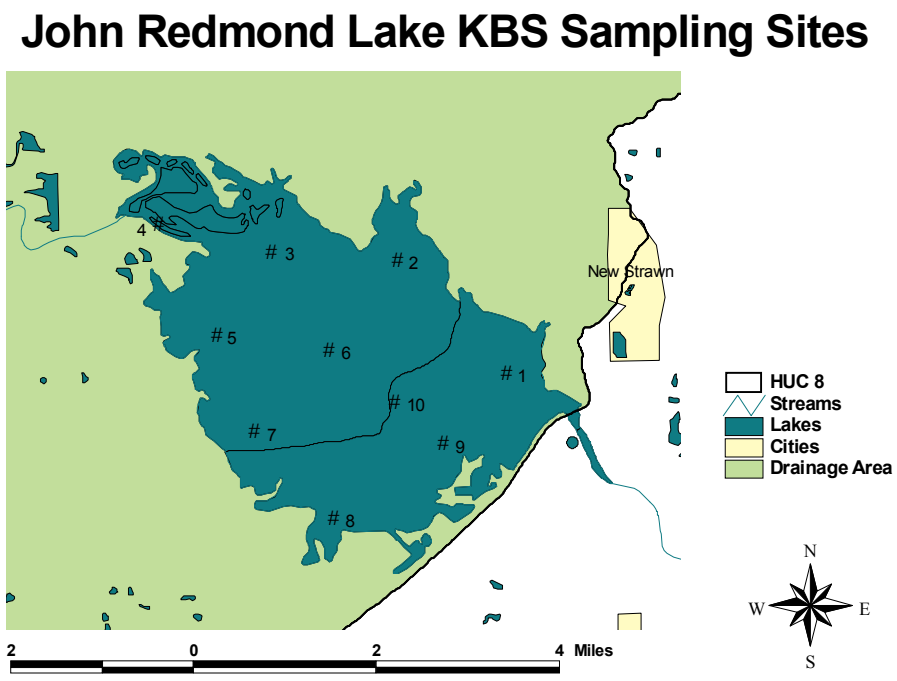
1. Oligotrophic	TSI < 40
2. Mesotrophic	TSI: 40 - 49.99
3. Slightly Eutrophic	TSI: 50 - 54.99
4. Fully Eutrophic	TSI: 55 - 59.99
5. Very Eutrophic	TSI: 60 - 63.99
6. Hypereutrophic	TSI: $\geq$ 64

From June of 1999 to November of 2000, the Kansas Biological Survey collected data at ten stations (Figure 2) in John Redmond Lake. A summary of those results is included in the below table.

Average Concentrations of Samples Taken by the Kansas Biological Survey

Location	Total Phosphorus (μg/L)	Total Nitrogen (mg/L)	Chlorophyll a (μg/L)
Station 1 - Lacustrine	**208**	**1.52**	**28.49**
Station 2 - Riverine	**266**	**1.79**	**33.12**
Station 3 - Transitional	**265**	**1.67**	**35.95**
Station 4 - Riverine	**239**	**1.73**	**40.34**
Station 5 - Transitional	**241**	**1.71**	**37.94**
Station 6 - Transitional	**202**	**1.51**	**33.73**
Station 7 - Transitional	**271**	**1.55**	**29.38**
Station 8 - Transitional	**189**	**1.53**	**28.23**
Station 9 - Lacustrine	**191**	**1.55**	**27.11**
Station 10 - Lacustrine	**194**	**1.54**	**32.56**

Figure 2



Loads were calculated for the Neosho River and Cottonwood River subwatersheds. From this analysis, it is evident that the Cottonwood subwatershed is making the greatest contribution to the phosphorus and nitrogen load. This conclusion is consistent with the land use assessment, because the Cottonwood River subwatershed has a larger drainage area and a greater number of Livestock Waste Management Systems and NPDES sites than the Neosho River subwatershed.

Average Concentrations and Load at Stream Monitoring Stations

KDHE Station (USGS Station)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Median Flow (cfs)	Flow Weighted Total Phosphorus Load (lb/day)	Flow Weighted Total Nitrogen Load (lb/day)
275 - Cottonwood Rv near Plymouth (07182250)	0.210	1.32	286	2,482	5,636
581 - Neosho Rv near Americus (07179730)	0.173	1.01	70	887	1,752

Interim Endpoints of Water Quality (Implied Load Capacity) at John Redmond Lake over 2007 - 2011:

In order to improve the trophic condition of the lake from its current Argillotrophic status, the desired endpoint will be to maintain summer chlorophyll a concentrations below 12 μg/L. The Total Nitrogen concentration in the lake should be maintained below 0.62 mg/L. A regression of 2000 - 2001 lake data and 1997 - 2000 wetland data was used to determine the current, in-lake nitrogen concentration and to calculate how much of a nutrient reduction was need to meet water quality standards.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: Forty-eight NPDES permitted facilities are located within the watershed (Figure 3). Ten are non-overflowing lagoons. Eighteen are unrelated to this TMDL (such as quarries and metal finishing facilities) or discharge into Council Grove or Marion Lakes and thus do not directly impact John Redmond Lake. The remaining twenty have the potential to contribute to the nutrient load; they are listed below.

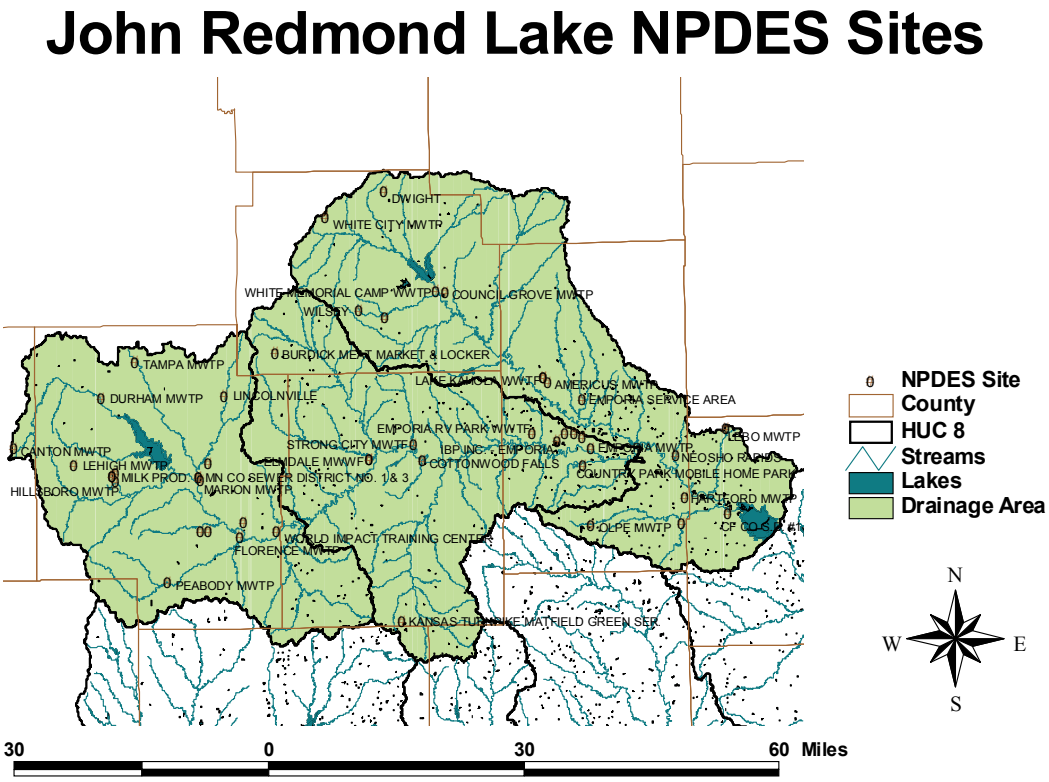
Discharging NPDES Facilities in the John Redmond Lake Watershed

Discharging NPDES Facilities	Type	Design Flow (MGD)	Permit Expiration Date
EMPORIA MWTP	Trickling Filter, CMAS Basin,UV	4.6000	12/31/03
IBP INC. - EMPORIA	Slaughtering operation	2.6000	12/31/03
MARION MWTP	Three Cell Lagoon	0.5400	12/31/03
HILLSBORO MWTP	Activated Sludge	0.4200	01/01/03
COUNCIL GROVE MWTP	Three Cell Lagoon	0.4080	09/30/04
PEABODY MWTP	Trickling Filter^	0.2100	12/31/03
LEBO MWTP	Four Cell Lagoon	0.1400	12/31/03
ASSOCIATED MILK PRODUCERS, INC.	Two aeration ponds, Clarifier	0.1350	closed 8/6/98
AMERICUS MWTP	Three Cell Lagoon	0.1258	12/31/03
COTTONWOOD FALLS MWTP	Five Cell Lagoon	0.1200	01/01/03
STRONG CITY MWTP	Three Cell Lagoon	0.1050	12/31/03
HARTFORD MWTP	Three Cell Lagoon	0.0500	12/31/03
OLPE MWTP	Three Cell Lagoon	0.0500	12/31/03

NEOSHO RAPIDS MWTP	Three Cell Lagoon	0.0450	12/31/03
LINCOLNVILLE MWTP	Three Cell Lagoon	0.0320	06/30/03
WILSEY MWTP	Two Cell Lagoon	0.0228	01/01/03
KS TURNPIKE MATFIELD GREEN	Three Cell Lagoon*	0.0160	12/31/03
COUNTRY PARK MOBILE HOME COURT	Two Cell Lagoon	0.0112	08/31/03
COFFEY CO. S.D. #1 (JACOBS CREEK)	Three Cell Lagoon	0.0108	08/30/03
KS TURNPIKE - EMPORIA SERVICE AREA	Three Cell Lagoon*	0.0082	12/31/03

*Will soon build a non-discharging lagoon. ^New lagoon under design.

Figure 3



Based on the design flow and the estimated total phosphorus loading from the lagoons and mechanical plants, the current total phosphorus load is 250,295 pounds per year. For IBP, Inc. in Emporia, the design flow and the average, annual total phosphorus concentrations were used in calculating the load (Appendix F).

Below is a list of the non-overflowing NPDES facilities. Non-overflowing lagoons are prohibited from discharging and may contribute a total phosphorus or ammonia load under extreme precipitation events (flow durations exceeded up to 5 percent of the time). Such events would not occur at a frequency or for a duration sufficient to add to the impairments in John Redmond Lake.

Non-overflowing Facilities in the John Redmond Watershed

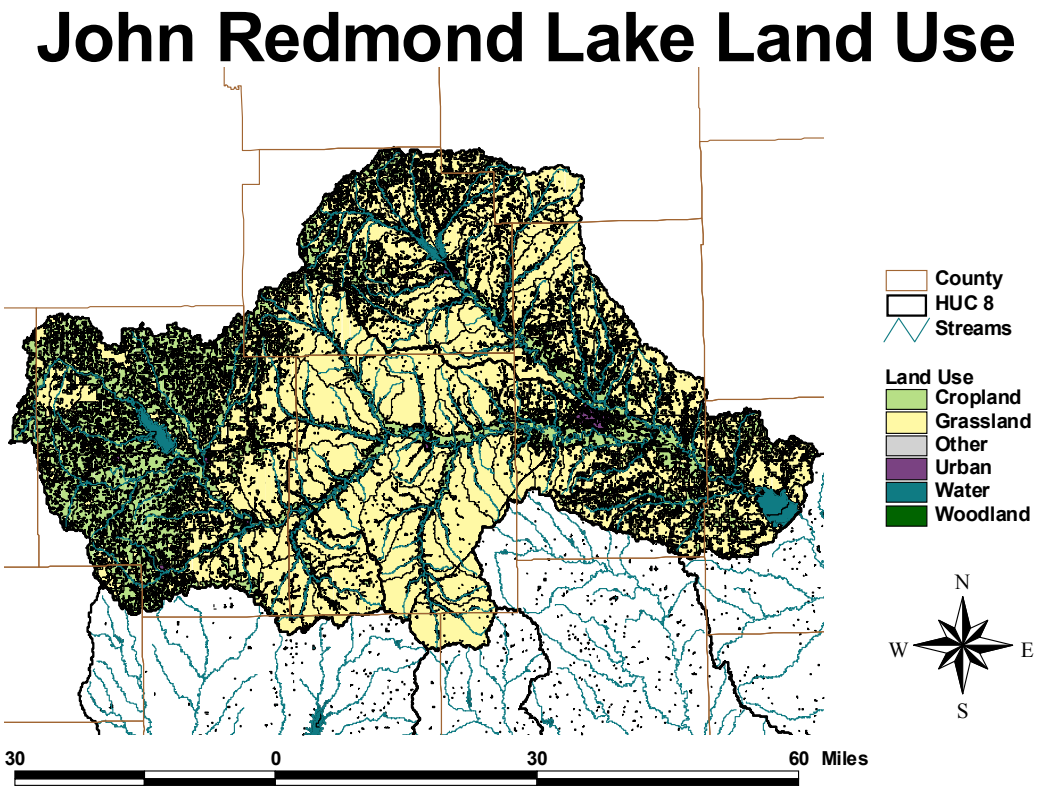
Facility Name	Type	Expiration Date
BURDICK MEAT MARKET & LOCKER	lagoon	6/30/04
ELMDALE MWWF	Three Cell Lagoon	5/31/04
EMPORIA RV PARK WWTF	Two Cell Lagoon	4/30/04
FLORENCE MWTP	Three Cell Lagoon	4/30/04
LAKE KAHOLA WWTF	One Cell lagoon	6/30/04
MARION CO. I.D. #3 WASTEWATER TREATMENT	Two Cell	12/31/02
MARION COUNTY SEWER DISTRICT NO. 1	Two Cell Lagoon	1/31/04
TAMPA MWTP	Two Cell Lagoon	4/30/04
WHITE MEMORIAL CAMP WWTP	Two Cell Lagoon	1/1/04
WORLD IMPACT VOCATIONAL TRAINING CENTER	Two Cell Lagoon	8/31/04

Among the thirty cities within the watershed, a 5.1% increase is anticipated through 2020. The following population changes are expected:

Expected Population Change from 2000-2020

Name	% Change
Alta Vista	8.3%
Americus	-4.0%
Burns	-5.8%
Bushong	-10.9%
Cedar Point	-19.2%
Cottonwood Falls	1.4%
Council Grove	10.7%
Dunlap	-19.7%
Durham	-11.4%
Dwight	2.1%
Elmdale	0.0%
Emporia	3.7%
Florence	10.2%
Hartford	-1.7%
Hillsboro	27.2%
Lebo	24.4%
Lehigh	5.1%
Lincolnville	-10.3%
Lost Springs	0.0%
Marion	-7.4%
Matfield Green	-20.0%
Neosho Rapids	3.3%
New Strawn	15.5%
Olpe	-0.7%
Parkerville	-16.0%
Peabody	-4.6%
Strong City	0.0%
Tampa	-12.9%
White City	8.4%
Wilsey	-8.8%

Figure 4



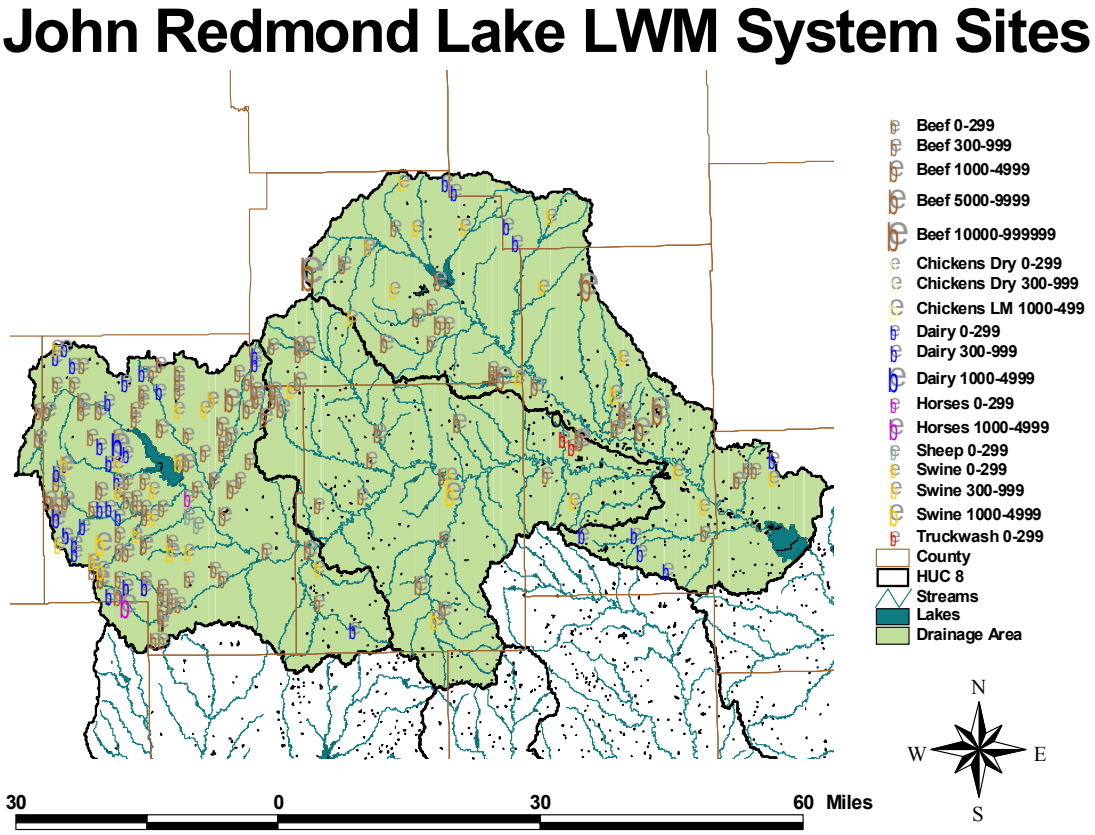
Land Use: The watershed around John Redmond Lake has a high potential for nonpoint source pollutants. The watershed contribution is 1,603,277 pounds per year; 1,352,982 pounds per year comes from nonpoint sources (Appendix E).

One source of phosphorus and nitrogen within John Redmond Lake is probably runoff from agricultural lands where phosphorus has been applied. Land use coverage analysis indicates that 30.2% of the watershed is cropland (Figure 4).

Phosphorus and nitrogen from animal waste are a contributing factor. Sixty-five percent of land around the lake is grassland; the grazing density of livestock is moderate in summer and high in winter. Animal waste, from confined animal feeding operations, adds to the nitrogen and phosphorus load going into John Redmond Lake (Figure 5). There are 39 dairy, 133 beef, 37 swine, 2 horse, 2 sheep, and 4 poultry animal feeding operations in the watershed. Thirteen of these facilities are NPDES permitted, non-discharging facilities with 52,608 animal units. All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed to retain the 25 year, 24 hour rainfall/runoff event, as well as an anticipated two weeks of normal wastewater from their operations. Such a rainfall event typically coincides with stream

flows which are exceeded 1-5 percent of the time. Therefore, events of this type, infrequent and of short duration, are not likely to add to chronic impairment of the designated uses of the waters in this watershed. Requirements for maintaining the water level of the waste lagoons a certain distance below the lagoon berms ensure retention of the runoff from the intense, local storms events. In Lyon County, where many of the facilities are relatively close to the river, such an event would generate 6.3 inches of rain, yielding 5.1 to 5.9 inches of runoff in a day. Potential animal units for all facilities in the watershed total 102,540 (active: 94,260 animal units; inactive: 8,280 animal units). The actual number of animal units on site is variable, but typically less than potential numbers.

Figure 5



Septic systems are located around the lake. The largest town in the watershed is Emporia. Less than one percent of the watershed is urban; stormwater runoff and urban fertilizer applications are a minor contributing factor. The population density of the Cottonwood subwatershed is 18.0 people per square mile. The density in the Neosho subwatershed is 20.4 people per square mile. Failing septic systems can be a significant source of nutrients. The following number of septic systems is present within the county:

Number of Septic Systems in County

County	Approximate Number of Septic Systems
Butler	5641
Chase	716
Coffey	1074
Greenwood	1465
Harvey	1802
Lyon	2063
Marion	1666
McPherson	2289
Morris	1589
Wabaunsee	1424

Contributing Runoff: The Council Grove subwatershed's average soil permeability is 0.4 inches/hour according to NRCS STATSGO database. About 98.5% of the watershed produces runoff even under relatively low (1.5"/hr) potential runoff conditions. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from only 48.2% of this watershed, chiefly along the stream channels.

Background Levels: Three percent of land in the watershed is woodland; leaf litter may be contributing to the nutrient loading. The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nitrogen loads may be contributed from the atmosphere. Carp may cause some resuspension of sediment.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While light is the limiting factor in John Redmond Lake, Total Phosphorus is also allocated under this TMDL. Because phosphorus is attached to sediment, the total phosphorus concentrations will decline as the total suspended solids concentrations are reduced. The Load Capacity is 1,399,864 pounds per year of phosphorus. The phosphorus Load Capacity was calculated with a regression of the total suspended solids and total phosphorus concentrations at station 273, Neosho River at Neosho Rapids (Appendix E). More detailed assessment of sources and confirmation of the trophic state of the lake must be completed before detailed allocations can be made. The general inventory of sources within the drainage does provide some guidance as to areas of load reduction. Because of atmospheric deposition, initial allocations of nitrogen will be based on a proportional decrease in nitrogen between the current condition and the desired endpoint.

Point Sources: This impairment is associated with the Waste Treatment Plants. Ongoing inspections and monitoring of these NPDES sites will be made to ascertain the contributions that have been made by the source. These Waste Treatment Plants should comply with any future permit limits. The Wasteload Allocation should be at 193,304 pounds of total phosphorus per year, a 22.8% reduction in current estimated total phosphorus loading. (See Appendix E for the detailed Waste Load Allocations). As previously noted in the inventory and assessment section,

sources such as non-discharging permitted municipal facilities and livestock waste management systems located within the watershed do not discharge with sufficient frequency or duration to add to an impairment in the lake.

Nonpoint Sources: Nonpoint source pollutants contribute to the water quality violations. Background levels may be attributed to atmospheric and geological sources. The assessment suggests that cropland and animal waste contribute to the elevated total phosphorus and nitrogen concentrations in the lake. Generally a Load Allocation of 1,066,574 pounds of total phosphorus per year, leading to a 21.2% reduction, is necessary to reach the endpoint. A Load Allocation of 888,456 pounds of total phosphorus per year is designated for the Cottonwood River subwatershed; 178,118 pounds per year goes to the Neosho River subwatershed. A proportional decrease of 60% in nitrogen loading will allow the total nitrogen endpoint to be achieved.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus loads and the chlorophyll a endpoint. Therefore, the margin of safety will be 139,986 pounds per year of total phosphorus taken from the load capacity subtracted to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. For nitrogen, the margin of safety will be an additional 6% reduction in nitrogen to ensure that the endpoint is reached.

State Water Plan Implementation Priority: Because John Redmond Lake is a federal reservoir with a relatively large watershed and a large regional benefit for recreation and state invested water supply, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Neosho Headwaters (HUC 8: 11070201) with a priority ranking of 38 (Medium Priority for restoration).

Priority HUC 11s: The Cottonwood River subwatershed (HUC 11: 11070203010, 11070203020, 11070203030, and 11070203040) should take priority. Secondary focus should be placed the Neosho River subwatershed.

5. IMPLEMENTATION

Desired Implementation Activities

There is a very good potential that agricultural best management practices will allow improved use support to take place in John Redmond Lake. Some of the recommended agricultural practices are as follows:

1. Implement soil sampling to recommend appropriate fertilizer applications on cropland.
2. Maintain conservation tillage and contour farming to minimize cropland erosion.
3. Install grass buffer strips along streams.
4. Reduce activities within riparian areas.
5. Implement nutrient management plans to manage manure application to land.

Implementation Programs Guidance

NPDES-KDHE

a. Evaluate nutrient loading from municipal dischargers in the watershed.
b. Work with those dischargers on reducing their individual loadings.
c. Control phosphorus loads from IBP, Inc.

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction of sediment runoff from agricultural activities as well as nutrient management.
b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.
c. Provide technical assistance on nutrient management in vicinity of streams.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.
b. Provide sediment control practices to minimize erosion and sediment and nutrient transport.

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.
b. Develop riparian restoration projects.
c. Promote wetland construction to assimilate nutrient loadings.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.
b. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.
c. Provide technical assistance on livestock waste management systems and nutrient management plans.
d. Provide technical assistance on buffer strip design and minimizing cropland runoff.
e. Encourage annual soil testing to determine capacity of field to hold nutrients.

Time Frame for Implementation: Priority consideration for installing pollution reduction practices within the stream drainage should be made after the year 2007. Evaluation of local water quality improvements in the watershed should occur prior to 2007 along with evaluation and upgrade of any inadequate point source contributors.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the lake. Initial work in 2007 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total row crop acreage
2. Cultivation alongside lake
3. Drainage alongside or through animal feeding lots
4. Livestock use of riparian areas
5. Fields with manure applications

Milestone for 2007: The year 2007 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from John Redmond Lake should indicate probable sources of nutrients and plans in place to initiate implementation.

Delivery Agents: The primary delivery agents for program participation will be conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

6. The *Kansas Water Plan* and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Medium Priority consideration.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to establish nutrient ratios, source loading and further determine mean summer lake trophic condition, would be of value prior to 2007. Further sampling and evaluation should occur once before 2007 and once between 2007 and 2011.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Neosho Basin were held January 9, 2002 in Burlington and March 4, 2002 in Council Grove. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin.

Public Hearing: Public Hearings on the TMDLs of the Neosho Basin were held in Burlington and Parsons on June 3, 2002.

Basin Advisory Committee: The Neosho Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2001, January 9, March 4, and June 3, 2002.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Kansas Farm Bureau: February 26 in Parsons and February 27 in Council Grove

Milestone Evaluation: In 2007, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of John Redmond Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period,

consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

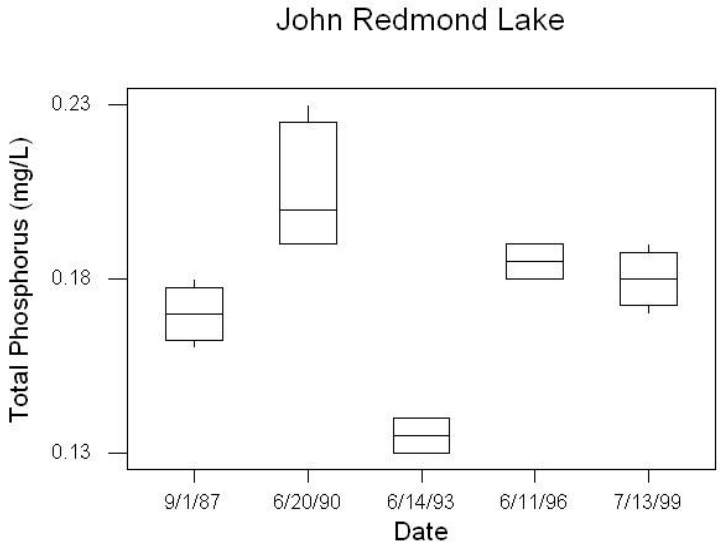
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

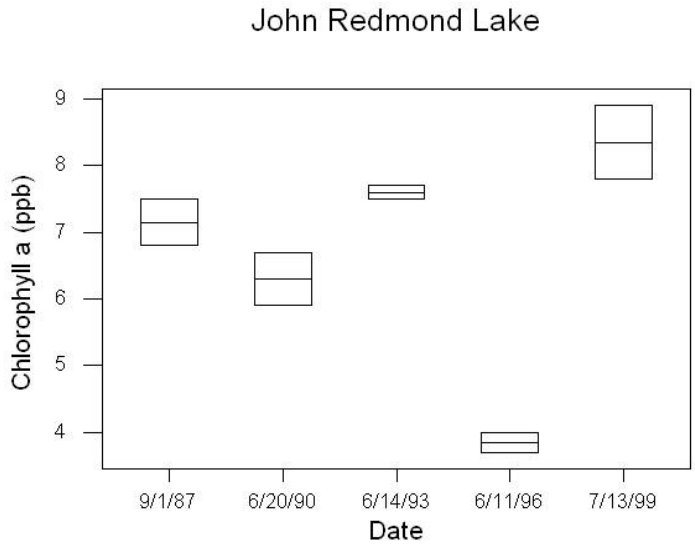
Bibliography

Lim, Niang Choo. "Assessment of Reservoir Water Quality and Its Application to Reservoir Management in the Central Plains." Thesis. University of Kansas. 2001.

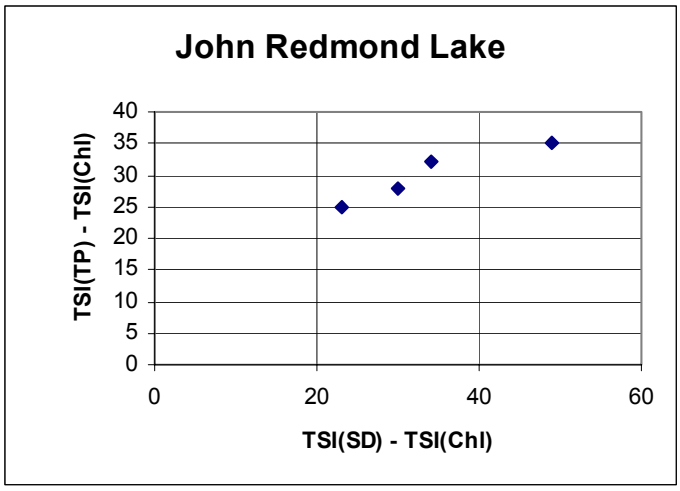
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 17 May 2002].

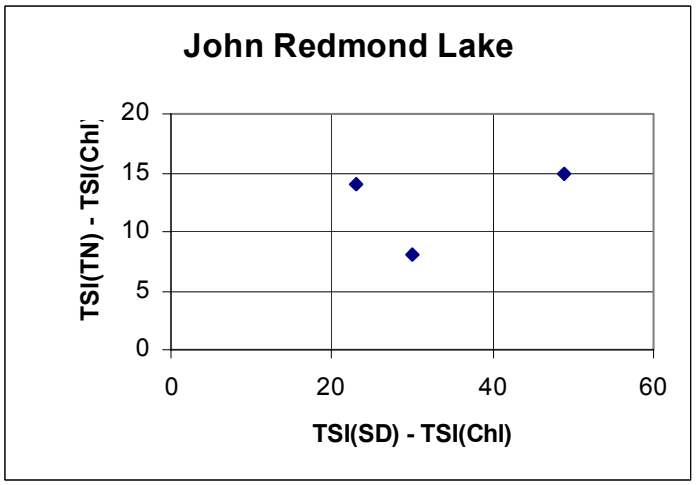
Appendix A - Boxplots





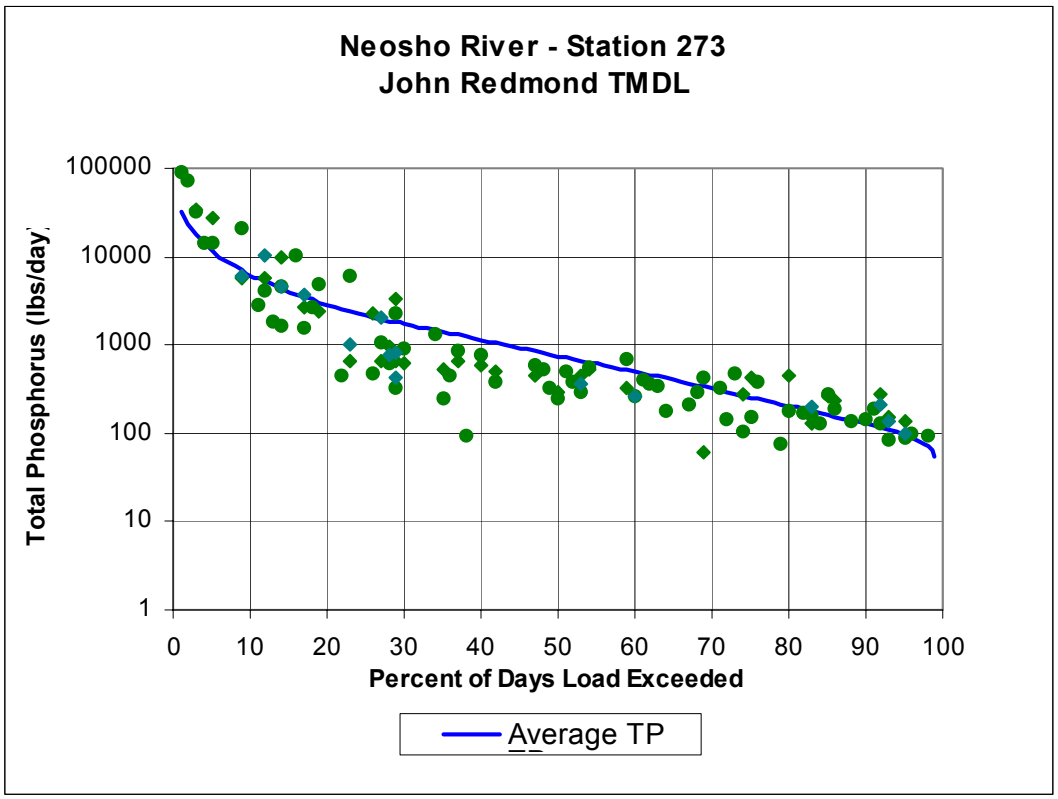
Appendix B - Trophic State Index Plots

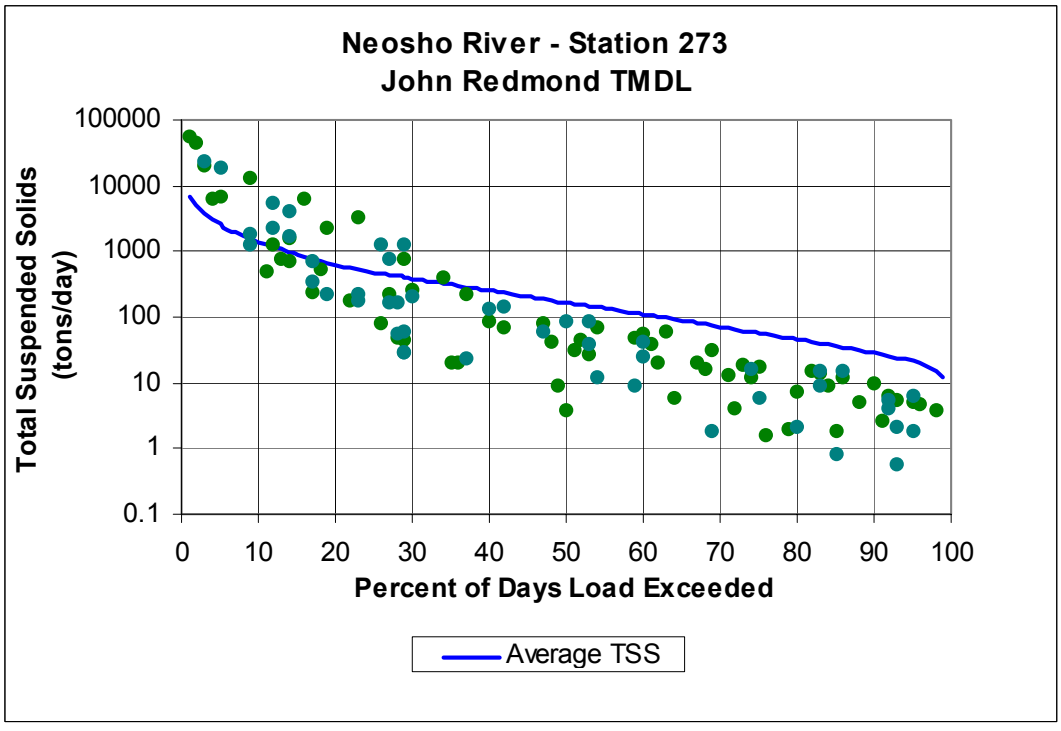




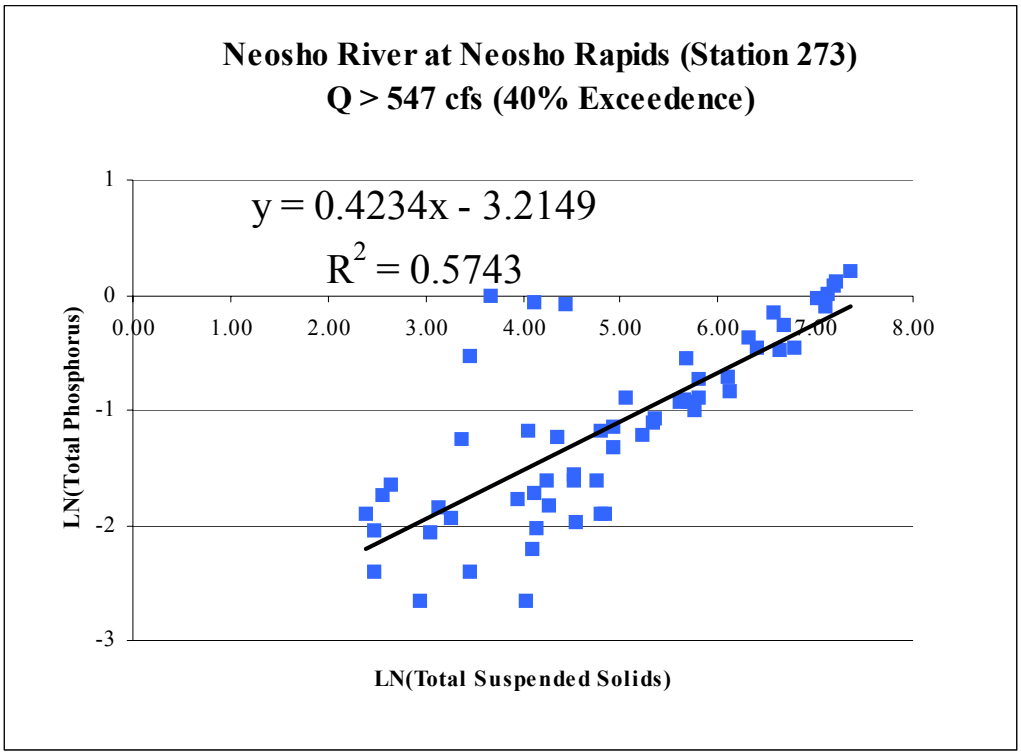
The Trophic State Index plots indicate that light is the primary limiting factor, due to clay turbidity. This is inferred by examining the relationship between the TSI(SD) - TSI(Chl) and TSI(TP)-TSI(Chl) or TSI(TN)-TSI(Chl). The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and phosphorus, or chlorophyll and nitrogen indicates the level of phosphorus or nitrogen limitation. Therefore, if the final plot is in the first quadrant, it shows that the transparency of the water is impaired due to the presence of small particles, and that phosphorus and nitrogen do not limit algae growth. The positive slope of the graph also indicates a correlation between phosphorus and transparency which is found when phosphorus is bound to non algal particles.

Appendix C - Load Duration Curves





Appendix D - Relationship between Total Phosphorus and Total Suspended Solids



Appendix E - Current Condition & Load Reductions

	TSS (Acre-Feet/yr) from Siltation TMDL	TSS load (tons/yr)	TSS Load (lb/day)	TSS (mg/L)*	TP (mg/L) from regression	TP Load (lb/day)	TP Load (lb/yr)
Current Condition	693	905,612.4	4,962,259.7	747.0	0.66	4,392.5	1,603,276.7
Load Capacity	503	657,320.4	3,601,755.6	542.2	0.58	3,835.2	1,399,864.2

*Average Flow = 1,230.2 cfs

Current Condition	TP Load (lb/yr)	
Total Phosphorus Current Condition	1,603,277	
Point Source Contribution	250,295	
Nonpoint Source Contribution	1,352,982	
Load Reductions	TP Load (lb/yr)	% Reduction
Total Phosphorus Load Capacity^	1,399,864	
Waste Load Allocation	193,304	22.8%
Load Allocation	1,066,574	21.2%
Margin of Safety	139,986	

^LC = WLA + LA + MOS

Appendix F

Estimated Existing Loads

Facility	Design Flow (MGD)	Permit Limits (mg/L) [*actual concentration]		Permitted Load (lb/day)		Average Concentration (mg/L)		Average Flow (MGD)	Waste Load Allocation Total Phosphorus (lb/day)
		NH3	Estimated TP	NH3	TP	NH3	TP		
EMPORIA MWTP	4.600	4.2	3.5	161.3	134.4	0.5		2.6	134.4
IBP INC. - EMPORIA	2.600	3.0	23.3*	65.1	504.8	2.0	23.3	1.8	348.6
MARION MWTP	0.540	monitor	2.0	monitor	9.0	N/A			9.0
HILLSBORO MWTP	0.420		3.5		12.3	N/A			12.3
COUNCIL GROVE MWTP	0.408	monitor	2.0	monitor	6.8	N/A			6.8
PEABODY MWTP	0.210	monitor	3.5	monitor	6.1	10.7			6.1
LEBO MWTP	0.140	monitor	2.0	monitor	2.3	N/A			2.3
AMERICUS MWTP	0.126	monitor	2.0	monitor	2.1	N/A			2.1
COTTONWOOD FALLS MWTP	0.120		2.0		2.0	No Discharge			2.0
STRONG CITY MWTP	0.105	monitor	2.0	monitor	1.8	N/A			1.8
HARTFORD MWTP	0.050	monitor	2.0	monitor	0.8	N/A			0.8
OLPE MWTP	0.050	monitor	2.0	monitor	0.8	N/A			0.8
NEOSHO RAPIDS MWTP	0.045	monitor	2.0	monitor	0.8	N/A			0.8
LINCOLNVILLE MWTP	0.032		2.0		0.5	No Discharge			0.5
WILSEY MWTP	0.023		2.0		0.4	No Discharge			0.4
KS TURNPIKE MATFIELD GREEN SERVICE AREA	0.016	monitor	2.0	monitor	0.3	5.0			0.3
COUNTRY PARK MOBILE HOME COURT	0.011		2.0		0.2	N/A			0.2
COFFEY CO. S.D. #1 (JACOBS CREEK)	0.011	monitor	2.0	monitor	0.2	No Discharge			0.2
KS TURNPIKE AUTHORITY - EMPORIA SERVICE AREA	0.008	monitor	2.0	monitor	0.1	11.0			0.1
Total	9.515				685.7				529.6

Approved Feb. 27, 2003